1132. Cyperus Lancastriensis Porter. Law.
1133. Eleocharis obtusa Schultes. Law.
1134. Scleria triglomerata Mx. Law., Leav.
1135. Carex aristata R. Br. Ellin.
1136. Carex Douglasii Boott. Ellin.
1137. Carex angustata B. strictior Dewey. Ellin.
1138. Aristida purpurascens Poir. Sal.
1139. Calamagrostis longifolia Hook. Ellin.
1140. Panicum (Paspalum ?) glabrum Gaud. Topeka; Popenoe.
1141. Panicum villosum Ell. Sal.
1142. Panicum dichotomum var. sphærocarpum Law. var. barbulatum Law.
1143. Tricuspis ambigua Ell. Topeka; Popenoe.
1144. Festuca ovina L. var. brevifolia, possibly duriuscula fls. 9. Ark. City.
1145. Eatonia Pennsylvanica D C. Law., Ark. City.
1146. Poa serotina Ehrh. Ellin.
1147. Glyceria Canadensis Trin. Law., Ellin.
1148. Equisetum lævigatum Braun. Sal.

AMERICAN JURASSIC DINOSAURS.

By S. W. Williston, New Haven, Conn.

The recent discoveries of abundant Dinosaur remains in the Rocky Mountain region, has given a renewed interest to the study of this singular order of extinct reptiles. Since the discovery, in March, 1877, of fragments of these animals in the upper Jurassic beds of Colorado and Wyoming, there have been exhumed not less than thirty tons of their remains, an amount probably exceeding all hitherto brought to light, both in Europe and America. The larger proportion of these collections are now in the museum of Yale College, and the remainder in Philadelphia, where, from their future study by the indefatigable paleontologists, Marsh and Cope, the final solution of their structure and affinities may be confidently expected.

The history of their discovery is both interesting and remarkable. For years the beds containing them had been thoroughly studied by geologists of experience, under the surveys of Hayden and King, and their position and extent carefully described and mapped out, but yet, with the possible exception of the half of a caudal vertebra, obtained by Hayden, and described by Leidy as a species of Poikelopleuron, not a single fragment had been recognized! This is all the more remarkable from the fact that in several of the localities, thus mapped out, I have observed acres, literally strewn with fragments of bone, many of them extremely characteristic, and so large and conspicuous as to have taxed the strength of a strong man to lift them! Three of the localities known to me are in the immediate vicinity, if not upon the actual town-sites, of thriving villages, and for years numerous fragments have been collected by tourists, and exhibited as specimens of petrified wood! The abundance and wide extent of their remains is almost incredible. The quantities hitherto obtained, although apparently so vast, are wholly unimportant in comparison with those yet

awaiting the researches of geologists, throughout the entire Rocky Mountain region; I doubt not that many thousands of tons will eventually be exhumed.

To an English geologist, Prof. Arthur Lakes, of Golden, Colorado, credit is due for first detecting the osseous character, and appreciating the scientific value, of these fossils. While engaged one day, in March, 1877, in company with Engineer E. L. Berthoud, of Colorado, in collecting Dakota leaves from the summit of the ridge, or "Hog-back," near Morrison, he discovered a huge caudal vertebra in bas-relief upon a slab of sandstone. Upon further investigation, a large quantity of bones were collected and shipped to Prof. Marsh, of Yale College, by whom they were described under the name of Titanosaurus montanus.

Almost contemporaneously with this discovery, the fossils were made known at Canyon City, Colorado, by Mr. O. Lucas, a school teacher, and in Southern Wyoming by Mr. Wm. Reed, an intelligent section foreman of the Union Pacific Railroad. Specimens from the former locality were sent to Prof. Cope, of Philadelphia, by whom they were named Camerasaurus supremus. Since then numerous other localities have become known in Colorado and Wyoming, and I doubt not but that future explorations will bring to light scores of outcrops rich in these vertebrate remains.

The beds consits of argillaceous shales of a grayish, or bluish gray color, variously interspersed with sandy, or sandstone strata, of from four to six hundred feet in thickness, the fossils extending through at least 300 feet in a vertical altitude. At Canyon City the deposits lie immediately upon the characteristic red sandstones of the Trias, the fossils having been detected to within seventy-five feet of the conglomerate. The beds are apparently conformable, as shown by the erosion of the valleys of two small streams, lying in a synclinal basin, the ridges of which are convergent, thus giving a transverse strike to the uneroded strata between the valleys.

Skirting the eastern flanks of the foothills, and extending for several hundred miles through Colorado and Wyoming, is a prominent ridge, or "Hog-back," of several hundred feet in height, dipping often at an angle of from 40 to 60 degrees, and usually protected above by the hard leaf-bearing sandstone of the Dakota cretaceous. Along the western slope of this ridge the fossiliferous clays or sandstones are usually concealed beneath the debris washed over them, but whenever exposed, as is often the case on the sides of valleys cutting through the Hog-back, fragments of dinosaur bones may generally be detected. Such is the case at Morrison, near Denver, where large quantities have been collected for the museum of Yale College. The fossils here extend to within at least 200 feet of the well-defined Dakota sandstone. Here, however, below the beds, the marine deposits of the Jurassic are prominent, and all, together with the red Triassic, lying conformably upon the carboniferous.

The stratigraphy is most characteristically shown at Como in Southern Wyoming. The summit of an anticlinal ridge has here been excavated, and a basin formed for an alkaline lake. A steeply inclined ridge of several miles in length is prominent immediately south of the lake with the fossiliferous strata largely exposed. The fossil outcrops here extend from near the summit of harder sandstone, which has not yet produced any cretaceous fossil leaves, down to near the marine beds containing an abundance of characteristic Jurassic invertebrates. The bluish clayey shales here preponderate, but are variously interspersed with admixtures of clay and sand, soft and hard sandstones, in all of which fossils are found, in some cases even large bones being imbedded, partly in sandstone, partly in shale. Invertebrate fossils are extremely rare. Of the vertebrates the individuals most

numerously represented are the tortoises, (Compsemys) with not infrequent teeth of Ceratodus, and vertebræ probably of the same. Of isolated teeth, those most frequently met with pertain to the crocodiles and carnivorous dinosaurs. Isolated bones of single individuals of the larger species are occasionally found, but not in a single instance do I know of numerous bones, pertaining to one skeleton of such species, being found unmixed with other remains. By far the most commonly, extensive deposits, or "quarries," are found containing remains of numerous individuals mingled together in the most inextricable confusion, and in every conceivable position, with connected limb bones standing nearly upright, connected vertebræ describing vertical curves, etc., precisely as though in some ancient mud holes these huge monsters had become mired and died, and succeeding generations had trodden their bones down, and then left their own to mingle with them. Such extreme confusion is however only seen in the clay deposits containing fewer waterworn fragments and small animals.

In sandstone deposits the large bones, though variously intermingled, are generally lying more nearly horizontal, with abundant waterworn fragments, and numerous remains of turtles, crocodiles, fishes, and small saurians.

These beds have hitherto been classified as the lower or Dakota group of the cretaceous, and still are by Prof. Cope. That no marked line will be found separating these estuary deposits from the Dakota, as defined by the distinguished paleontologist, Prof. Lesquereux, is possible, but until better evidence is obtained among the invertebrates to unite them, it will be far more reasonable to accept the evidence of the vertebrates, and assign to them, as Prof. Marsh has done, an equivalency with the European Wealden or Upper Jurassic.

So far, in addition to the dinosaurs, one species each, of fish, tortoise, crocodile, (Diplosaurus Msh.) pterodactyl, (P. montanus Msh.) and mammal (Dryolestes priscus Msh.) have been described from this formation. Of the dinosauria, so far thirteen genera have been characterized by Profs. Marsh and Cope, as follows: Titanosaurus Msh, (Atlantaurus Msh), Stegosaurus, Msh, Nanosaurus Msh, Camerosaurus Cope; Apatosaurus, Msh, Allosaurus Msh, Caulodon Cope, Trichosteus Cope, Amphicoelias Cope, Mososaurus Msh, Creosaurus Msh, Laosaurus Msh, and Diplodocus, Msh, and of which probably one-half are synonyms. Titanosaurus and Camerasaurus are without much doubt synonymous, and the latter is considered by Prof. Owen identical with his Chonlrosteosaurus, which is, however, only known from two imperfect vertebræ from the English Wealden. The same evidence would however include Apatosaurus and Mososaurus, but among these there are certainly two valid genera, as proved by the structure of the pelvic girdle, and hence, till the original type of Chondrosteosaurus is better known, it will be premature to unite the American species with it. According to the rules of Zoological nomenclature, no genus is entitled to acceptance, unless it is distinctively characterized. But so long as it is the custom to define genera from single bones, or uncharacteristic parts of the skeleton, such a rule has its objections. If, as in the present case, several genera, which can not be individually separated from the original imperfect type, are successively eliminated, the last must assume the type name; but this original genus may be found, when better known, to be distinct from any of them, or perhaps identical with some other one previously eliminated. Or, perhaps imperfect specimens may be found that can not be generically separated from others in remote formations, and where to unite them would be doing violence to our preconceived opinions of the persistence of geological types. But, on the other hand, the indiscriminate application of names

to genera, that can neither be positively united with, or separated from, previous ones, is pernicious.

The group of saurians represented by these four or five genera, including also Amphicoelias and Diplodocus, together with Ceteosaurus, Owen and other European ones, have been characterized by Marsh under the name Sauropoda, which, together with Huxley's Ornithoscelida, or true dinosaurs, have been made suborders of Dinosauria. They are intermediate between the crocodilia and true dinosaurs. They were the largest of terrestial animals, herbivorous, probably amphibious, and awkward and slow in their movements. The head, and especially the brain, was very small, the neck long, the dorsal vertebræ massive in their proportions, but cavernous and pneumatic, so interlocked as to give great strength and but little beuding. The sacrum of several vertebræ, solidly united, and the tail heavy and long. They walk upright upon all four nearly equal massive legs; the feet with five short toes. The largest of these described by Prof. Marsh could not have been less than eighty feet in length and twenty feet in height, and, probably, thirty tons or more in weight. Although of such almost incredibly gigantic proportions, they were doubtlessly inoffensive and harmless in their nature, relying neither upon agility or defensive weapons for protection, but rather upon size alone.

Stegosaurus was described by Marsh as a separate order, but it is possibly allied to the Sauroscelida. It was a large reptile with a heavy dermal osseous plates or exoskeleton.

The Ornithoscelida are represented by Nanosaurus, Laosaurus, Allosaurus, Creosaurus, and a species referred to the Cretaceous genus Drytosaurus (Laelaps) by Cope, and indicate three well marked families.

Nanosaurus was the smallest, and together with Compsognathus, from the European Wealden, to which it is probably allied, the most ornithic of known reptiles. They were animals scarcely larger than a cat, with short thighs, and long, slender legs, the limb bones being extremely hollow and pneumatic, as in most birds. They doubtlessly walked erect upon the two hind limbs, with very short and weak fore limbs, and were quick and agile in all their habits.

Laosaurus was a genus of dinosaurus very closely allied, perhaps identical, with Iguanodon and Hypsilophodon of the European Jurassic. They were herbivorous animals, which, in the largest known species, measured perhaps ten feet in length, or, when standing erect upon their hind legs, which they must have habitually used, were about five feet high. The head was of moderate size and the teeth serrated upon the edges; the neck was short, not at all slender; the shoulders small, and the fore legs not more than half as long as the hind ones. The pelvis showed a singular mingling of the bird and reptile types. The pubes and ischia, if united in symphyses at the ends very feebly so, and probably not at all. The pubes had two rami or branches, the anterior one, the homologue of the lizard or crocodile pubis, a slender spatulate bone, with free ends; the posterior branch or bird pubis, long, slender rod-like bones, extending back parallel to the ischia, in a manner particularly like the struthious birds. The thigh and leg bones were of nearly equal length, rather slender and hollow; the tarsus very similar to that in the bird, the foot slender and three-toed. The tail was probably rather long and compressed from side to side. Other species were smaller, of less than half the size of the larger ones. They were less bird-like than the preceding, but more so than the following.

Allosaurus and Creosaurus, which are possibly synonymous, together with Dryptosaurus trihedridon, comprising probably not more than two or three species, without much doubt included, together with Megalosaurus

and Poikelopleuron of the European Wealden, to which they are strongly allied, the most carnivorous and rapacious of terrestrial reptiles known. The teeth are long and sabre-like, recurved and minutely serrated, and the jaws were doubtless furnished with strong masseter muscles. The fore limbs were, in all, much smaller than the hinder; the neck was short, the tail probably slender, and very effective as a weapon. The pelvis is very imperfectly known in all the carnivorous genera, but was undoubtedly very narrow, as shown by the sacrum. The astragalus was very bird-like, with a high ascending process; the feet three-toed. The claws were extremely slender, curved, and pointed. The bones were all very hollow, light, and of dense osseous texture. Creosaurus is estimated at thirty feet in length. They probably habitually walked upon the hind feet, progressing rather by leaping than by strides.

Caulodon and Tichosteus are very imperfectly known from teeth and fragmentary vertebræ.

That not only in species, but also in individuals, this age was very prolific, seems probable from their abundant widely scattered remains, and moreover, localities but a few hundred miles apart, seem to differ much in their species. Not a single species has been found identical in any of the three localities mentioned above, although there possibly may be upon further study. Upon many obscure problems of the ancient Mezozoic life, much light may be confidently expected from the vast unexplored deposits of the Rocky Mountain Jura.

CRETACEOUS FORESTS AND THEIR MIGRATIONS.

By Prof. B. F. Mudge, Manhattan.

One of the most interesting problems of geology, is the study of the geographical distribution of animal and vegetable life over the globe, in the different geological ages, and more particularly the migrations from one portion of the earth to another, consequent on the sinking of one area beneath the ocean, and the rise of another. Such changes of land have been exceedingly slow, and consequently the migrations of animal and vegetable life have been equally so.

Prof. Asa Gray has recently, in the American Journal of Science, given us a very interesting essay on the origin by migration of our forests of America and Europe. He describes the close relationship of the living forests, and those fossilized in Greenland in the Miocene deposits. From a series of facts, he comes to the conclusion that the flora of both continents have descended from the common stock which lived in Greenland during the Miocene epoch. He stops there and goes no further back. He does not inquire from whence came the Greenland forests.

Now by the labors of Herr and others, we have a knowledge in detail of the Greenland flora, not only in the Miocene, but in the Upper Cretaceous. They show a near resemblance to the vegetable life of our Dakota group. As the latter is much older than the former, we now propose to give our reasons for believing that the Dakota epoch of Kansas, Nebraska, and some portions of the Rocky Mountain region, was the true and original nativity of the latter forests now fossilized in the deposits of Greenland.

To do this, the facts will be a little clearer if we show, by the labors